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Abstract

**Contests at the workplace with and without prize selection.
Testing theory in a field experiment**

by Rustamdjan Hakimov*

We conduct a field experiment with 302 workers of the microcredit company in Russia to study the effects of the different designs of a contest for monetary prizes at the workplace. We consider a standard all-pay auction design with two and four prizes of different size and compare it to "parallel" contests with the same prizes, but where participants have to choose the prize prior to the start of the competition and then the winner is selected only among the players who chose the same prize. Despite the theoretical predictions, the parallel contests lead to higher efforts for all players, but mainly by lower-ability players. Division of prizes leads to the predicted effects. In parallel contests, too many players choose the higher prize than equilibrium suggests. Overall, the parallel version of contests appeared to be more profitable for the firm.

Keywords: Contests, incomplete information, all-pay auctions, field experiment.

JEL classification: C78; I21

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1 Introduction

Millions of firms around the world introduce contests for their employees for monetary and non-monetary prizes. The term "contest" can describe a lot of different economic environments, from sport competitions to elections and college admissions. However, finding optimal contest design is still a complex question. The complexity of it comes from the fact that predictions of the existing contest models are sensitive to assumptions about the number of players, number and sizes of prizes, participants' heterogeneity in terms of abilities, and other parameters. Moreover, the different alternatives of contests, which vary in the way the winners are selected, are modeled in the literature. The comparison between different models, or contest designs, is even more difficult and sensitive to the parameters of the models.

One of the most common ways to determine winners in contests is through an all-pay auction design, where all participants are ranked according to their level of effort and the participant with the highest effort receives the best prize, the participant with the second-highest effort receives the second prize, and so on. These types of contests are quite common. [1] The examples of these types of contests are broad, and include all kinds of sport championships, competition for leadership positions and grants, centralized college admissions, and so forth. They are fairly common for firms, too: best employee of the month, best salesmen of the month, etc. In the following we refer to these contests as "standard" contests.

Recent theoretical and experimental evidence on the standard contest design shows some undesirable features of the standard' contests: in case of heterogeneity among players the efforts may be too heterogeneous, and lower ability players will not actively participate in the contest (Müller and Schotter, 2010). The authors call this behavioral regularity "bifurcation". A similar observation was found by De Paola et al. (2012) in a field experiment, when only higher ability students increased their productivity in response to a contest introduced for obtaining better grades in exams. Other undesirable features of the standard contests include the great observed variance of efforts even given the same ability (Nalbantian and Schotter, 1997, and Eriksson et al., 2009) and possibilities of sabotage (Harbring and Irlenbusch, 2011).

Some of the problems might be mitigated by varying the parameters of the contests, like introducing multiple prizes and varying the number of participants. The equilibrium of the all-pay auctions contest with multiple prizes under incomplete information was characterized by Moldovanu and Sela (2001). The optimal allocation of a fixed amount of prize money depends on the convexity of the cost function, keeping other parameters fixed. A convex enough cost function leads to higher effort under multiple prizes than under a single prize (Moldovanu and Sela, 2001). This

[1] These contests are also modeled as rank-order tournaments. In the rank-order tournaments the level of efforts is not observable and the outcome, which is a noisy measure of efforts, is used to determine the winners of the contest. In what follows we assume full observability of efforts or absence of randomness in the rank-order tournaments. Thus, two models coincide.

theoretical result was supported by experiments by Müller and Schotter (2010). [2]

Lately, another variation of the contest has been discussed and analyzed in the literature, when participants must choose the prize they compete for and the effort simultaneously. The winners are then determined for each prize only from the subset of players who chose to compete for the same prize. In what follows we refer to them as "parallel" contests. Examples of such contests are decentralized college admission, parallel tournaments of the same professional association (like in tennis, WTA and ATP), some TV shows, like the popular singing competition "The Voice", where everyone chooses their coach and competes for the final only against those who chose the same coach. The equilibrium of parallel contests with incomplete information is characterized by Hafalir et al. (2014). The authors also show that in the lab, players exert more effort in parallel contests than in standard all-pay auction contests, even when theory predicts the reverse relation. Buyukboyaci (2012) finds similar results in a simpler environment with just two players: the total effort exerted in lab in parallel contests is higher when players have heterogeneous abilities. Importantly, in parallel contests there is not much support for a bifurcation of efforts in the lab. These findings motivate the current field experiment. Can the positive effect of the parallel contests on effort provision in the lab be replicated in a field setting?

We conduct an experiment with 302 workers at a microcredit company in Russia to compare the effects of standard and parallel contests for monetary prizes at the workplace. For one month the workers competed for different prizes with nine other random workers from the company without knowing their identities. We use a 2x2 design, varying the number and the size of the prizes and the contest design. In the first two treatments we used an all-pay auction contest. We varied the number of prizes: either two prizes, one of 20,000 rubles and one of 10,000 rubles, or four prizes, two of 10,000 rubles and two of 5,000 rubles. [3] In the other two treatments we used parallel contests'. Before the start of the contest participants had to choose the prize for which they wanted to compete, and then the winner was determined as the best performer among those who chose the same prize. We used the same variation of prizes in these treatments. The fifth group of credit specialists was in the control group, where no contest was introduced. The effort was defined as the number of new clients that were attracted by the worker in the course of the month and the winners were determined by the highest efforts.

Regarding the results, the average effort levels in all contest treatments are significantly higher than the average efforts in the control group. The highest average efforts were reached in the parallel contest's treatments. In line with the lab findings of Hafalir et al. (2014) we observe higher efforts in the parallel contests than in standard contests. We check the efforts relation

[2] Lately Cason et al. (2010) show benefits of the contest similar to the lottery contest modeled by Tullock in Buchanan et al. (1980). Authors show that a contest with proportional prize devision attracts a higher participation of lower ability participants that standard contest. We do not consider these type of contest in the paper. For the recent review of experimental evidence on both standard and lottery contest check Dechenaux et al. (2015).

[3] The exchange rate in February 2015 was around 70 rubles per 1 EUR. The average monthly salary of a credit specialist was 35,000 rubles.

of participants with different abilities and find that efforts are higher in the parallel contests for all abilities, even when the theoretical predictions go in th opposite direction. For within-model comparison, we find some support for the effects of the prize division in both contest designs: higher ability players exert more effort in treatments with a small number of high prizes in both contests, while lower ability types exert higher efforts in treatments with a higher number of smaller prizes in standard contest. In parallel contests, the high-ability types chose the prize in line with equilibrium, while lower ability types chose the high prize too often. In line with equilibrium, we find no difference in efforts depending on the choice of the prizes, controlling for ability. The efforts predicted by Moldovanu and Sela (2001) and Hafalir et al. (2014) have strong predictive power for the realized efforts by ability types: they fully explain the treatment difference between control and standard contest treatments, but an additional positive difference remains between the control group and the parallel contests treatments. This observation is in line with the lab findings that motivated this experiment where parallel contests lead to higher effort than the theory currently suggests.

2 Experimental design

2.1 Preliminaries

The experiment was conducted in February 2015 at the offices of Mol.Bulak microfinance company in Russia. Mol.Bulak focuses on microloans to the labor migrants which come to Russia for work, mostly as cheap labor, from the countries of Central Asia: Kyrgyzstan, Tadjikistan, and Uzbekistan.[4] The company had 45 offices all over the Russia from Vladivostok to Kaliningrad with 302 credit specialists in total in February 2015. The company's management decides on the range of available loan options and the terms at which they can be taken up. There were in total eight available combinations of the length of the loan term and the sum of loan for new clients during the period of the experiment. The company's credit specialists are responsible for finding clients, assessing their creditworthiness, and supervising regular repayments of the loans. Usually, the company's clients are in direct contact with a credit specialist, who is typically the only contact person between the company and the clients. All the company's credit specialists participated in the experiment.

The payment scheme for all credit specialists throughout the firm and all its branches in Russia was as follows before and during the experiment: a flat fixed salary plus a progressive bonus,

[4] Mol.Bulak is a unique microfinance company that offers loans without a collateral to migrants in Russia. The target group of migrants is a very risky group, as they do not have permanent registration address, often switch jobs and have a high probability to leave Russia for the country of origin or move to another region of Russia. They do not have any credit history records, except the one inside of the company.However, the migrants often need money for registration in Russia, payment for housing or sending cash back to the families in the home-country who are most of the time dependent of their transfers. These migrants do not have access to credits in Russian credit institutions. The efficient rate of credit was around 75% and the percent of returned credits around 90%

Table 1: Treatments

		Within -model variation	
		2 Prizes 20,000 RUB; 10,000 RUB	4 Prizes 2 of 10,000 RUB; 2 of 5,000 RUB
Between-model variation	Standard contest	**Standard2**	**Standard4**
	Parallel contest	**Parallel2**	**Parallel4**

depending on productivity. However, there is a threshold of productivity under which the bonus is 0. Productivity at the company is defined as a combination of the number of clients and the quality of the returns (low portfolio at risk value). Thus, the design of the compensation scheme led to the fact that a credit specialist below the threshold for bonuses could have a low motivation for exerting the efforts, as the bonus seemed to be too far away. Moreover, due to frequent changes in compensation schemes in the past, some workers could not believe that the long-term effort of reaching the threshold would pay-off, as new changes could be introduced. These considerations led the management to believe that a short-term intervention in the form of contests with the possibility to earn money could have a strong effect on the efforts of the specialists.

For one month the credit specialists competed for different prizes with nine other random workers from the company without knowing their identities. For the goals of the contest their productivity was defined as the number of new clients which they attracted in February. The specificity of the business allows us to assume that the number of new clients is a direct result of the effort exerted by the credit specialist. Moreover, the management was convinced that most of the workers did not work at the maximum of their aptitude to attract new clients. Another important motivation for choosing this specific performance indicator as a main input of contest is that all the company's credit specialists had the same chance of winning, as it did not depend on previous productivity. We chose not to inform the credit specialist of the name of their competitors, and guaranteed that they had been matched randomly by demonstration of the assignment procedure. By doing so we tried to minimize the possibility of discouragement effects which are typically observed in contests in the lab. Finally, the lack of information about competitors allowed us to exclude all potential sabotage possibilities.

2.2 Treatments

We use a 2x2 design, varying the number and the size of prizes given fixed budget (within-model) and the contest architecture (between models). Table 1 presents the summary of parameters of the treatments.

In the first two treatments we use the well-known all-pay auction contest under incomplete information by Moldovanu and Sela (2001). We vary the number of prizes: either two prizes, one of 20,000 rubles and one of 10,000 rubles, or four prizes, two of 10,000 rubles and two of 5,000 rubles. Thus, in the first treatment, which we call "Standard2"' each group of 10 workers competes for two prizes. The credit specialist with the highest number of new clients in the month of February received the prize of 20,000 rubles, and the credit specialist with the second-highest number of new clients received 10,000 rubles. In the second treatment there are four prizes in total for each group of ten workers: two of the credit specialists with the highest number of the new clients received 10,000 rubles, and the credit specialists with the third and fourth-highest number of new clients received 5,000 rubles. We call this treatment "Standard4." In the other two treatments contestants could choose the prize they competed for prior to the start of the competition, thus separating themselves from the contestants who chose the other prize. The winner was determined as the best performer among those who chose the same prize. We use the same prize variations as in standard treatments. Thus, in the third treatment, which we call "Parallel2," every credit specialist had to choose the prize of either 20,000 rubles or 10,000 rubles, and the credit specialist with the highest number of new clients in February, among those who had chosen the same prize, received the corresponding prize. In the fourth treatment, there were two prizes of 10,000 rubles and two prizes of 5,000 rubles, and the credit specialists had to choose the prize (10,000 or 5,000), and the two credit specialists with the highest number of clients, among those who had chosen the same prize, received the corresponding prize. We call this treatment "Parallel4." The fifth group of credit specialists was the control group, where no contest was introduced. Note that the explained bonus incentives were still present in all treatments and the control group, thus the incentives of contests are introduced additionally to the existing incentives in the company.

The treatment randomization was done at the office level, so every credit specialist of an office was in the same treatment condition. According to the management of the company there is no interaction between the credit specialists of the different offices even if there are several offices in the same city (which was only the case for Moscow and Saint-Petersburg). The first criterion for a balanced randomization was the office size with respect to the number of specialists. The management suggested that there is a big difference in the environment and manner of interaction between large and small offices. We ranked all offices by the number of employees and randomly assigned a treatment number between 1 and 5 starting from five largest offices, then to the five offices of rank six to 10 and so on. Thus, offices with the same number were assigned to the same treatment. The resulting assignment led to an unequal distribution of the number of the credit specialists between treatments, with a maximum of 64 credit specialists per treatment and a minimum of 57. As we aimed to have 60 credit specialists in each treatment with a contest, we reallocated small offices from the treatments with too many workers to treatments with less than 60 workers. This was possible due to the presence of three offices with two credit specialists and three offices with one credit specialist.

The procedure of the randomization at the first level left few possibilities for additional adjustments. We checked for the average number of clients per credit specialist by treatments as it can be a proxy for ability of credit specialists. This parameter was lower in the Standard4 treatment than in other treatments, though in a non-significant way due to high variation. In order to exclude possible imbalance in ability, we switched the assignment of one successful office with five credit specialists from treatment Parallel2 to treatment Standard4, while moving less successful office with five employees from Standard4 to Parallel2. This switch finalized the treatment assignments.

The introduction of the treatments was done as follows: on Friday, January 30, every head of the office[5] in all treatments other than the control announced to the credit specialists that contests would be held for monetary prizes. The competition result would be determined by the number of new clients in the month of February and that everyone would compete with nine random other credit specialists from all the company's offices, and that they would not know each other's identities. The prizes and exact rules were not announced, but the managers announced that the CEO of the company would provide further instructions by email. It is important to note that emails from the CEO are a common way of communication in the company. Every credit specialist receives a smartphone after one month of employment with the installed internal email application. The push notifications of new emails are set, so that every time the credit specialist receives an email it pops up on her smartphone home-screen. Additionally, every day they receive an email with a list of credits with delayed payments and the number of credits issued during the month. The CEO received the list of emails addresses of the credit specialists grouped by treatments and had to send four different emails to these groups with hidden emails of the recipients on the afternoon of January 30. The process was supervised by me in person.

The emails for each of the treatments are presented in appendix A.2.

Additionally, all the office managers received the same email as credit specialists and were instructed to announce the start of the contest orally at the traditional office meeting on Monday, February 2. In case of any questions they could clarify them with the head of regions – their direct superiors. The two heads of regions (Asian and European) were given instructions by me personally about the contest and all treatments, and also had the list of offices with their assignment to each treatment. It was done to insure that the possible questions about the contests rules would be answered correctly.

2.3 Theoretical predictions

In this section we derive the equilibrium predictions for each of the treatments. Our model is all-pay auctions, contest, with incomplete information on ability and heterogeneous players in terms of ability. In particular, we adopt the models of Molodovanu and Sela (2001) for the standard contest, and model of Hafalir et al. (2014) for parallel contest, to derive the predictions for the setup of the experiment.

[5] In each of the company's offices there is an office chief who is the direct superior of the credit specialists. The heads of the office received the rules by email with the request to go through them in public on Monday, February 2, and were asked directly by the head of the regions whether the rules were clear.

2.3.1 The model

Ten risk-neutral players compete for two types of monetary prizes: Monetary Prize 1 and Monetary Prize 2. We denote the set of players by I and a generic player by i. We denote the set of prizes by M. The monetary prizes are available in different quantities, denoted by q_1 and q_2 respectively. Each player has a cardinal utility of m_1 for the Monetary Prize 1 and m_2 for Monetary Prize 2. We assume that Monetary Prize 2 is more desirable than Monetary Prize 1 to every player, that is $m_2 > m_1$. Each player i exerts the effort e_i. Players are heterogeneous in terms of their abilities. We take the interval $(0, 1)$ as the ability space. The abilities are private information and are drawn identically and independently from the interval $(0, 1)$ according to a continuous distribution function F. The distribution of abilities is common knowledge. A player i with ability a_i who exerts effort e_i bears a cost of effort $\frac{1}{a_i} \cdot e_i^{\alpha}$, $\alpha \geq 1$. The player's performance is determined by her effort e_i.

In the standard contest each player $i \in I$ exerts e_i. Given an effort profile $(e_i)_{i \in I}$, players with the top q_2 efforts receive the prize 2, and players with the efforts from top $(q_2 + 1)$ to $(q_2 + q_1)$ receive the prize 1.

Proposition 1. *In the standard contest, there is a unique symmetric equilibrium such that for each* $a \in (0, 1)$, *each player with ability* a *chooses effort* $e(a)$ *where the effort function* e *is a closed-form solution. See details in Appendix A.1*

In the parallel contests, each player $i \in I$ simultaneously chooses one of the prizes, M_i and an effort e_i. Given the prize choices of students $(M_i)_{i \in I}$ and efforts $(e_i)_{i \in I}$, each Prize M is awarded to players with the top q_M effort levels among the set of players who chose the prize $(\{i \in I \mid M_i = M\})$. The unique symmetric Bayesian equilibrium of this game is characterized in Hafalir et al. (2014), and the following Proposition is a special case of it, with a modification allowing for convexity of the cost function.

Proposition 2. *In a parallel contest, there is a* unique *symmetric equilibrium* $(\gamma, e; c)$ *where a player with type* $a \in (0, c]$ *chooses the monetary prize 1 (smaller prize) with probability* $\gamma(a)$ *and makes effort* $e(a)$; *and a player with type* $a \in [c, 1)$ *chooses prize 2 (higher prize) for sure and makes effort* $e(a)$. *The closed form solutions and details are in Appendix A.1.*

2.3.2 Treatment comparisons

Hypothesis 1 (Incentives): The average effort in all contest treatments should be higher than in the control group. Introducing contests incentives should lead to an increase in effort, as we assume that before the introduction of the incentives the credit specialists did not work with maximum motivation.

The equilibrium comparisons of the treatments is not possible without assuming a shape of the cost functions and the distribution of the abilities. We use a simulation approach to develop hypotheses for the experiment. Using Proposition 1 and Proposition 2, the equilibrium effort level for each ability is calculated in each treatment given assumptions on two parameters: α and F. We use a large variation of parameters that cover the most realistic cases.

For parameter α we use the values of {1,1.2,1.4}. Taking as extreme the linear shape of the cost function, we increase α, thus increasing the convexity of costs.

As for the distribution of the ability F, the theory restricts it to be bounded between $(0, 1)$. three alternative distributions are used in the simulations to derive predictions for the treatments: uniform (or beta distribution with parameters $\alpha = 1, \beta = 1$), beta distribution with parameters $\alpha = 2, \beta = 2$, and beta distribution with parameters $\alpha = 3, \beta = 3$. All the distributions have a mean of 0.5 and are symmetric but vary in terms of thickness of the tails. Section 2a of the appendix presents the figures with the simulated efforts comparing the standard and the parallel contests, and section 2b of presents the figures of simulated efforts comparing the contests with two and four prizes within each contest design.

We use the robust findings from the simulations to develop the following hypotheses that are not sensitive to the convexity of the cost function and the distribution of efforts.

Hypothesis 2 (Between-model comparison): The average effort of the intermediate ability types should be higher in the standard treatments than in parallel treatments with the same number of prizes.

Note that in equilibrium players with abilities around the theoretical cutoff c of the parallel contests always exert less effort in the parallel contest than in the standard contests. See figures 7 and 8 of the appendix. The intuition comes from the fact that players just above the ability cutoff win the good prize only if there are fewer higher ability players than number of good prizes and, unlike in standard contests, they do not have any chance of getting the smaller prize in the parallel contests, thus they exert less effort than the same ability types in the standard contests. For the abilities just below the cutoff, they most likely receive the smaller prize if they choose it in the parallel contests, and they do not face any competition from higher ability players in the equilibrium as the latter choose the high prize with certainty. Thus, players with abilities below the cutoff also exert less effort in the parallel contests than in the standard contests.

Hypothesis 3 (Within-model comparison): For high-ability types, efforts are higher in contests with two prizes. For low-ability types efforts are higher in contests with four prizes, but only in the standard contests.

Figure 9 in the appendix shows the relation of efforts in standard contests for players of different abilities. High-ability players always exert higher effort in two-prize treatments than in four-prize treatments, while the lower ability players exert higher efforts in four-prize treatments. The intuition is straightforward: in case of two prizes high-ability players have a chance to win a higher prize and exert more effort, while in case of four prizes more players have a high chance of a prize, and thus a larger part of the support of abilities exert a positive effort.

Figure 10 in the appendix shows the relation of efforts in parallel contests for players of different abilities. As in the standard contest treatments, high-ability players exert higher efforts in the case of two prizes. As for lower types, the relation is unlike in the standard contests: though the efforts of the lower ability players are higher in case of four prizes, the level of efforts are almost the same in the two parallel treatments. The intuition for it is that due to sorting in Parallel2, a larger support of abilities below the cutoff exert positive effort than one prize would suggest in the case of standard contests (as around 50% of the player choose the high prize). This moves the interval of the abilities, when four prizes could lead to higher effort to the left, where the cost of efforts is already much higher, and thus the difference in efforts is much smaller.

Hypothesis 4 (The choice of prizes in parallel contests): High-ability players choose the high prize with certainty. Lower ability players randomize the choice of prizes.

The hypothesis is a property of the equilibrium from Proposition 2. Figures 7 and 8 of the appendix show that the cutoff is sensitive to the distribution of abilities and is independent of the convexity of the cost function.

Hypothesis 5 (Effort choice in parallel contests): Irrespective of the prize choice, contenders exert the same effort, given ability.

Again, the hypothesis is a property of the equilibrium from Proposition 2, and we test it with our data.

3 Results

3.1 Randomization. Descriptive statistics

Table 2 presents the summary of characteristics of credit specialists by treatments. We present the data only for a sample of 286 credit specialists. The number of specialists in each treatment is smaller than was originally assigned. This is due to a number of employees being fired and specialists taking more than seven days vacation or being ill for more than seven days. Out of the 302 credit specialists on January 25 when the treatment assignment was done, only 293 were still employed in the company. In addition, seven were ill or took more than seven days vacations and are not used in the analysis. Thus, we use 286 observations.

There is no significant difference in the size of portfolio, number of new clients, age, gender composition, number of clients in January 2016, and the proportion of credit specialists who received a bonus between treatments. However, there are differences between the specialists in different treatments in PAR7.[6] Credit specialists in Parallel2 and Standard4 have, on average,

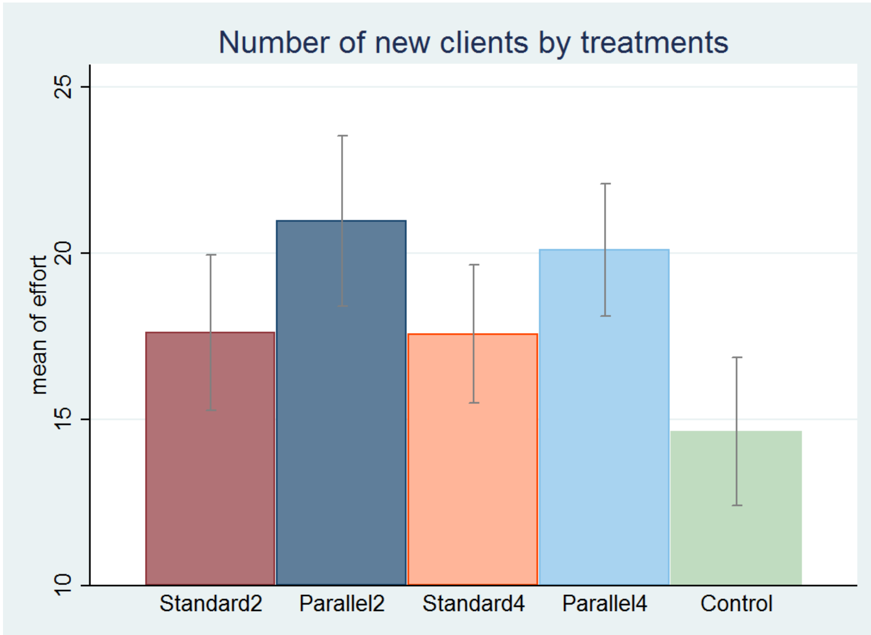
[6]PAR7 is a coefficient of portfolio at risk with delay of seven days or more.

Table 2: Descriptive statistics of the credit specialists characteristics by treatments

Treatment		Standard2	Parallel2	Standard4	Parallel4	Control	Total
Protfolio, 1000RUB	Mean	3,553	3,495	3,411	3,543	3,475	3,495
	Sd	1,900	2,023	2,220	1,771	1,894	1,954
Number of clients	Mean	164.2	167.7	166.7	167.5	167.4	166.7
	Sd	78.9	106	104.2	80.7	88.1	91.5
PAR7	Mean	0.09	0.08	0.08	0.1	0.09	0.09
	Sd	0.08	0.06	0.07	0.07	0.08	0.07
Experience, months	Mean	15.2	17.9	14.9	19.5	15.4	16.6
	Sd	10.8	14.4	11.8	10.5	9.9	11.6
Female dummy	Mean	0.47	0.51	0.40	0.40	0.50	0.45
	Sd	0.50	0.50	0.49	0.49	0.50	0.50
Age, years	Mean	34.4	33.1	34.2	32.8	34.9	33.9
	Sd	8.5	8.1	8.1	7.6	7.7	8
Nr. of new clients in January 2015	Mean	15	15.9	16.1	15.1	15	15.4
	Sd	9.3	8.8	8.3	7.6	7.1	8.2
Bonus dummy	Mean	0.07	0.05	0.09	0.05	0.07	0.07
	Sd	0.26	0.23	0.28	0.22	0.26	0.25

Notes: Portfolio shows the total sum of currently issued loans of credit specialists. PAR7 is a coefficient of portfolio at risk with delay of seven days or more. Bonus dummy is equal to 1 if a credit specialist received bonus in December 2014 and 0 otherwise.

lower PAR7 than credit specialists in Parallel4 (the difference is significant at a 10% significance level according to a two-sided Mann-Whitney test). Nevertheless we do not consider it to be a problem in treatment assignments as the relation of the high PAR7 to the potential to grow is unclear. On one hand, with a high portfolio at risk most of the time the specialists devote their resources to reclaiming some of the delayed payments. However, the specialists only have limited control over this and at some stage of the process most of the work of reclaiming the delayed payments will be in the hands of the company's credit control department. In the latter case, a credit specialist might feel motivated to find new clients to increase the overall credit balance and thus decrease the PAR7 coefficient. We control for the difference in PAR7 in the subsequent analysis. The credit specialists in the Parallel4 treatment have, on average, more experience than in Standard2, Standard4, and the Control treatments (Mann-Whitney test two-sided p-values for corresponding pairwise comparisons are: 0.03, 0.01, 0.06). All other pairwise differences are not significant. Once again, as in the case of PAR7, it is unclear how experience can affect the reaction to the treatment, and thus we control for it in the analysis of the results. In the following all significant results are reported at a 5% level and all p-values are two-sided, if not otherwise stated.



Notes: Confidence intervals are for 5% significance level.

Figure 1: Number of new clients by treatments.

3.2 Treatment comparison

Result 1 (Incentive effect): All contests lead to a significantly higher average effort of credit specialists than in the control group (only 10'% significance in Standard2). The efforts in Parallel2 are higher than in Standard2 and Standard4 (both 10% significance) and efforts in Parallel4 is higher than in Standard2 (10% significance) and Standard4.

Support.

Figure 1 shows the average number of new clients in the month of February by treatments. Credit specialists of the Parallel2 treatment attracted the highest number of new clients – 20.96 on average. In the control group the average number of new clients was only 14.93. For comparison, in January the average number of new clients among all the company's credit specialists was 15.4 per specialist. Wilcoxon ranksum test for equality of distribution of efforts between the control and Standard2 leads p-value 0.07, between the control and Parallel2 p-value 0.00, between the control and Standard4 p-value 0.05, and between the control and Parallel4 p-value 0.00. Thus we observe positive effect of the contests in all treatments. Moreover, comparison of Parallel2 to Standard2 leads p-value 0.07, Parallel2 to Standard4 0.07, Parallel4 to Standard2 0.09, and Parallel4 to Standard4 0.05. Thus, even in the raw data, without controlling for individual characteristics, we observe benefits of the parallel contests relative to the standard contest for the firm. Note that we observe result one in the raw data using non-parametric test. Additionally we run regressions in order to control for the individual characteristics of credit specialists by treatments. Columns 1 and 2 of Table 3 show the coefficients of linear regressions of the number of new clients on the dummy for each of the treatments. The number of new clients in Parallel2 and Parallel4 treatments is significantly higher than in Control. The number of new clients in Standard2 and Standard4 are 10% significantly higher than in Control. The significance is robust to controlling for the individual characteristics. Thus, the incentives of the experiment led to an increase in efforts, as expected in hypothesis 1. The difference to some other studies that failed to find the effect may be due to the relatively high incentives in the current experiment and the absence of a performance-based compensation scheme for the majority of the participants and in the control group. Note that this is the main result of the paper and is totally free from any assumptions on the parameters like ability distribution and the shape of the cost function.

Table 3: OLS regressions of efforts in contests relative to the control

	(1)	(2)	(3)
Standard2	2.96*	2.74*	2.20*
	(1.58)	(1.41)	(1.18)
Parallel2	6.33***	6.66***	5.44***
	(1.59)	(1.43)	(1.20)
Standard4	2.93*	2.86**	2.99**
	(1.57)	(1.40)	(1.17)
Parallel4	5.45***	6.33***	5.78***
	(1.57)	(1.42)	(1.19)
Individual controls		(yes)	(yes)
Ability estimate			26.12***
			(2.40)
Constant	14.64***	7.71***	1.93
	(1.11)	(2.40)	(2.07)
Observations	286	286	286
R^2	.0652	.4636	.5265
F-test	4.90	19.66	23.26

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Individual controls include all variables from Table 2

In order to provide further insights in the experimental results and understand the sources of the treatments effects some assumptions have to be done. To test hypotheses 2 to 5, the abilities of the credit specialists have to be estimated. One of the disadvantages of field experiments relative to lab experiments is the difficulty in disentangling efforts and abilities. To address this issue, two additional data points were collected for all credit specialists. The first includes the number of new clients by all credit specialists participating in the current study for the previous 11 months (March 2014 to January 2015) or since the start of their employment at the company. Assuming that every credit specialist was fully motivated and worked to the maximum of his or her ability at least once during their period of employment, we can reconstruct the abilities from the maximum monthly effort for the previous 12 months or for the period of employment in the company.

The estimation of the α parameter of the cost function is not feasible given the data available. Given the specificity of the business and the task of the credit specialists, we assume that the costs

	Coef.	Std. Err.	Z	P>z
alpha	2.53	0.20	12.43	0.00
beta	2.34	0.18	12.53	0.00

Table 4: Estimation of parameters alpha and beta for Beta distribution, based on the distribution of observed abilities

are close to linear: finding a second client requires the same number of steps or even fewer than finding the first. Fatigue may be present but it is unlikely to generate high values of the parameter α. The hypotheses under test are not sensitive to the parameter α, so we assume a low level of convexity, or α=1.2 for the purpose of deriving theoretical predictions and estimating abilities. Thus, we can calculate the ability of each credit specialist from the maximum exerted effort by using the following equation: $maxcost = \frac{e_i^\alpha}{a_i} = \frac{median^\alpha}{0.5}$

Thus, due to a assumption of the symmetric distribution of abilities, we assign an ability equal to 0.5 to credit specialists with the median maximum monthly effort. The median maximum monthly effort is 21. Using the equation above we calculate the abilities for each credit specialist. This procedure, however, does not guarantee that abilities will lie in the interval from 0 to 1. In fact four credit specialists received an ability higher than 1. In this case they are assigned an ability equal to 0.99.[7]

The second data we have collected is used for a robustness check. The heads of the regions, who are the direct superiors of the credit specialists, were asked the following question: "If the prize was 1 million rubles per each client, how many clients could each credit specialist find?". We use their expert estimate as the proxy for ability. By deriving the ability from these estimates in a similar way as shown above, the correlation of ability estimates from maximum effort and expert estimates is 0.70.

Given the estimated ability of each credit specialist, the parameters of distribution are estimated based on the actual distribution of abilities by fitting a two-parameter beta distribution to the distribution of estimated abilities by a conventional parameterization with shape parameters alpha > 0 and beta > 0 (Forbes et al., 2011). The results of the estimation are presented in Table 4. Figure 2 presents the fit of the estimated Beta distribution to the observed distribution of abilities.

Thus, for each treatment the theoretical prediction of effort is calculated assuming parameter $\alpha = 1.2$ and Beta(2.53, 2.34) distribution of abilities. Figure 3 shows the predicted efforts for each of the treatments, assuming zero effort in the control group, as only contest incentives are considered. It allows us to determine areas of abilities for which we expect a particular effort relation between the treatments, thus specifying hypotheses 2 to 5. It is useful to note that given the parameters of the model, the theoretical ability cutoff in the Parallel2 treatment is 0.715 and in the Parallel4 treatment 0.815.

[7]We assign ability 0.99 and not 1, as in what follows we assume Beta type of distribution, and estimate its parameters. As Beta distributions exclude values 1, we substitute extreme high values of abilities by 0.99.

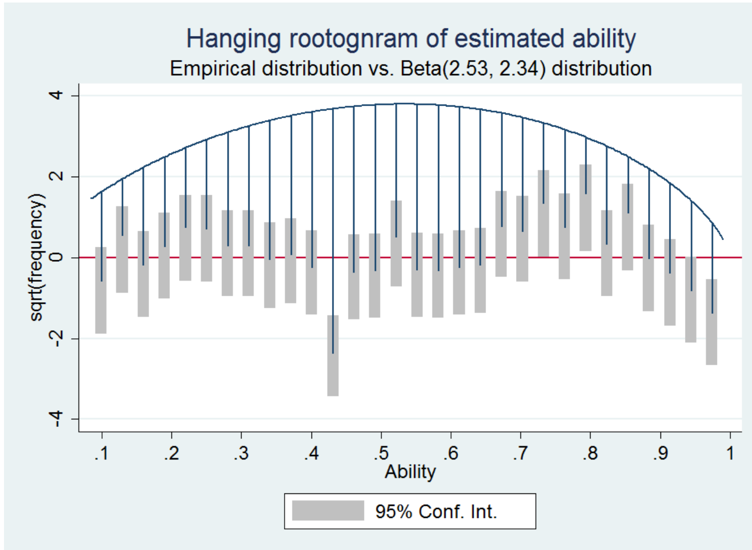


Figure 2: Empirical versus theoretical distribution of abilities.

Notes: Solid line above presents the density of Beta(2.53, 2.34) distribution. Each vertical gray rectangle shows the 5% confidence interval in square root scale of the difference between the observed and theoretical frequency of data in each of the ability intervals on horizontal axis.

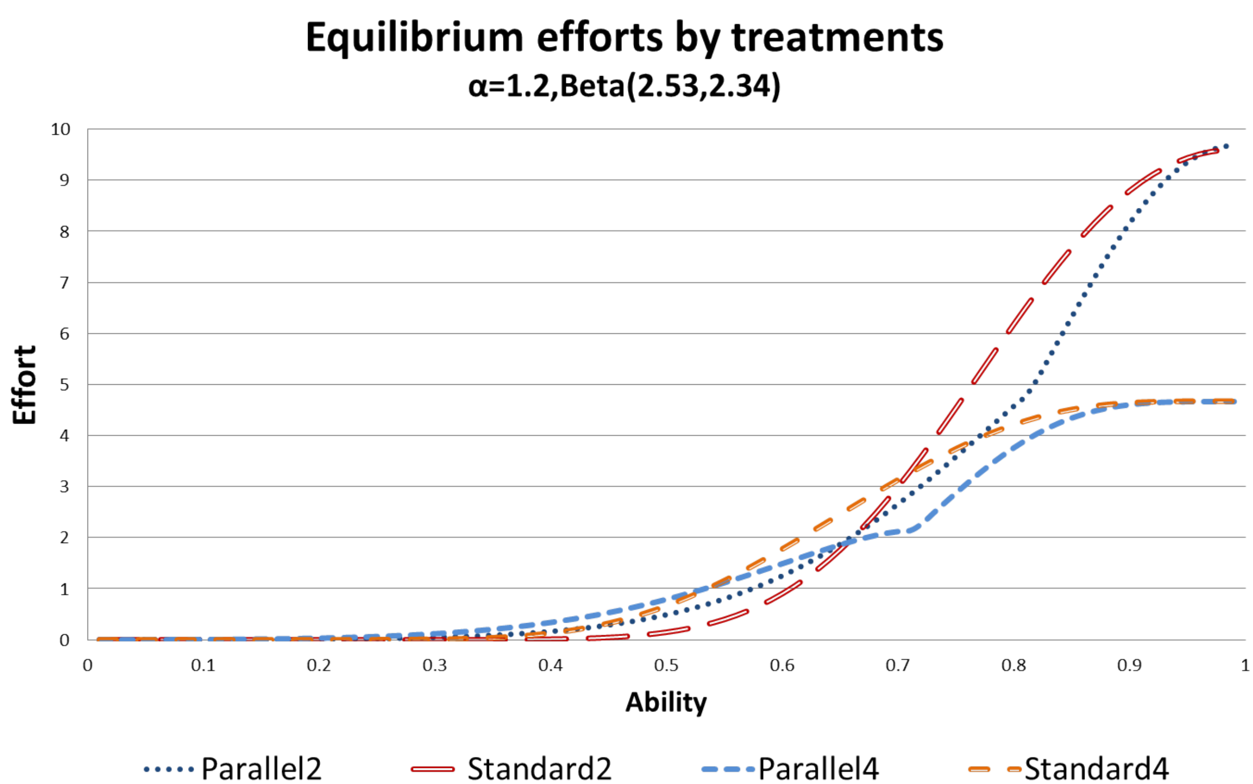


Figure 3: Equilibrium efforts by treatments.

Result 2 (Efforts by ability types): The effort level in the parallel contests is higher than in the standard contests with the same number of prizes for all abilities, irrespective of the theoretical predictions. The difference is significant for abilities from 0.40 to 0.59 in the case of two prizes, and for abilities below 0.47 in the case of four prizes.

Support. First, figure 4 shows the smoothed efforts by abilities grouped by treatments with the same number of prizes. Note that in equilibrium players with abilities around the cutoff always exert less effort in the parallel contest (hypothesis 2). In contrast to the predictions, efforts in the parallel contest are on average higher for all abilities, thus we observe no support for hypothesis 2. In order to identify the significance of the difference in efforts between treatments for different abilities, we first create dummy variables for each 10% quantile of the abilities distribution. For the intervals of the 10% quantiles we use the quantiles of Beta (2.53, 2.34) distribution. Table 5 presents the results of the linear regression of efforts in Standard2 and Parallel2 contests (columns 1 to 3) and Standard4 and Parallel4 contests (columns 4 to 6).

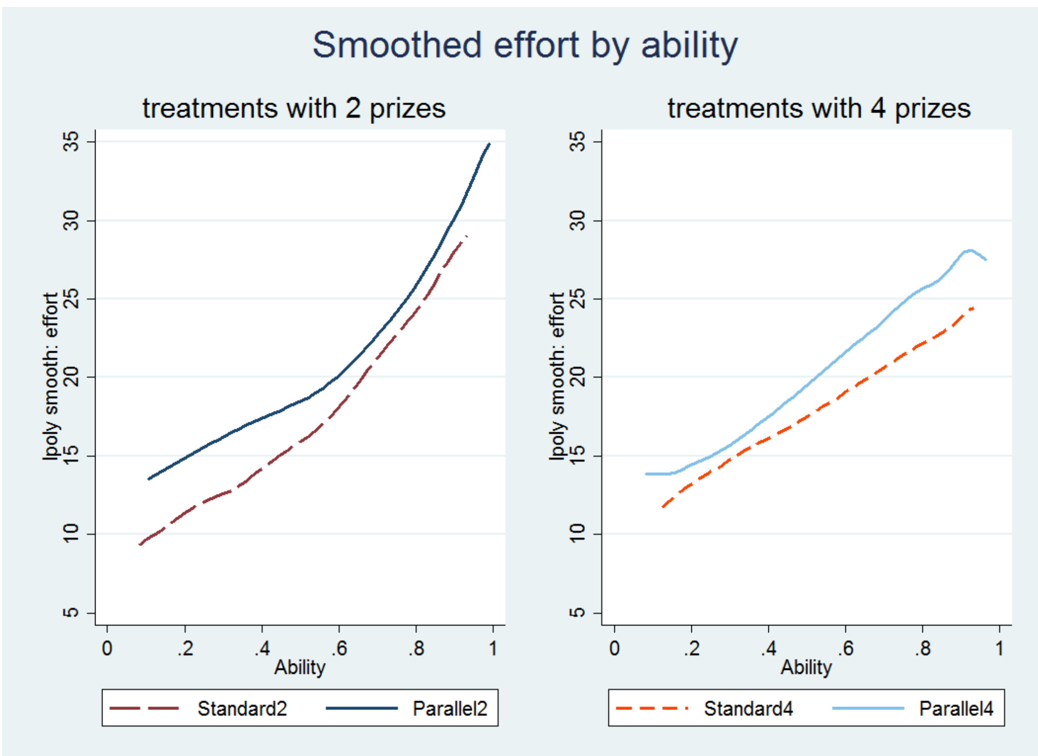


Figure 4: Smoothed effort by ability

Columns 1 and 4 show that there is a significant treatment difference of average efforts controlling for the ability of all participants (10% significance in case of four-prize contests). However, we are more interested in differences in efforts by ability groups because theoretical predictions vary across the different ability groups. For the contests with two prizes, efforts in Standard2 are significantly lower than efforts in Parallel2 for abilities of the third, fourth, fifth and sixth 10% quantiles of abilities. For the contests with four prizes, efforts in Standard4 are significantly

Table 5: Efforts in contests

	(1) effort 2 prizes	(2) effort 2 prizes	(3) effort 2 prizes	(4) effort 4 prizes	(5) effort 4 prizes	(6) effort 4 prizes
Ability	38.51***	38.66***	38.04***	25.19***	23.97***	25.84***
	(2.68)	(3.63)	(4.01)	(3.09)	(4.47)	(5.01)
Standard	-2.59**			-2.24*		
	(1.02)			(1.15)		
quantile 1-2 in Standard dummy		-.58	-.06		-2.62	-4.78**
		(2.41)	(2.44)		(2.34)	(2.26)
quantile 3-4 in Standard dummy		-3.47**	-3.48**		-3.66*	-4.10**
		(1.60)	(1.66)		(1.92)	(1.77)
quantile 5-6 in Standard dummy		-3.52**	-3.36**		-.87	-.68
		(1.63)	(1.69)		(1.92)	(1.87)
quantile 7-8 in Standard dummy		-.89	-.75		-2.02	-2.86
		(1.91)	(1.98)		(2.14)	(2.00)
quantile 9-10 in Standard dummy		-2.92	-3.12		-1.77	-4.80*
		(2.22)	(2.37)		(2.75)	(2.63)
Constant	.23	.15	.24	7.35***	7.97***	11.00***
	(1.62)	(2.09)	(3.11)	(1.76)	(2.40)	(3.09)
Individual controls	no	no	yes	no	no	yes
Observations	112	112	112	116	116	116
R^2	.67	.67	.70	.39	.39	.54
F-test	108.54	36.26	17.39	35.73	11.84	9.05

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Individual controls include all variables from Table 2

lower than efforts in Parallel4 for credit specialists of abilities in the first, second, third and fourth 10% quantiles of abilities. Note that there is also 10% significance of the differences in efforts in Standard4 and Parallel4 for the ninth and 10th quantiles of abilities.

Result 2 shows that between-model predictions for the relation of effort do not find much support in the data, thus we reject hypothesis 2. The biggest deviation comes from the players with abilities for which the standard contests should lead to higher efforts. Instead, we observe higher efforts in parallel contests, and this observation is in line with the results of the lab experiment of Hafalir et al. (2014). We also observe that the significance of the difference comes from the lower quantiles of abilities. Participants with these abilities almost certainly do not win a prize and barely exert any effort in the equilibrium of the standard contests. This is in line with the intuition that the lower ability players in the parallel contests might feel motivated by the belief that higher ability players are sorted out from competition and will choose the bigger prize. This observation is also in line with Buyukboyaci (2012).

3.3 Within-model comparison

Result 3 (Efforts by ability types): In the standard contests, the level of effort is significantly higher in the case of two prizes than in the case of four prizes for high-ability players. The reverse

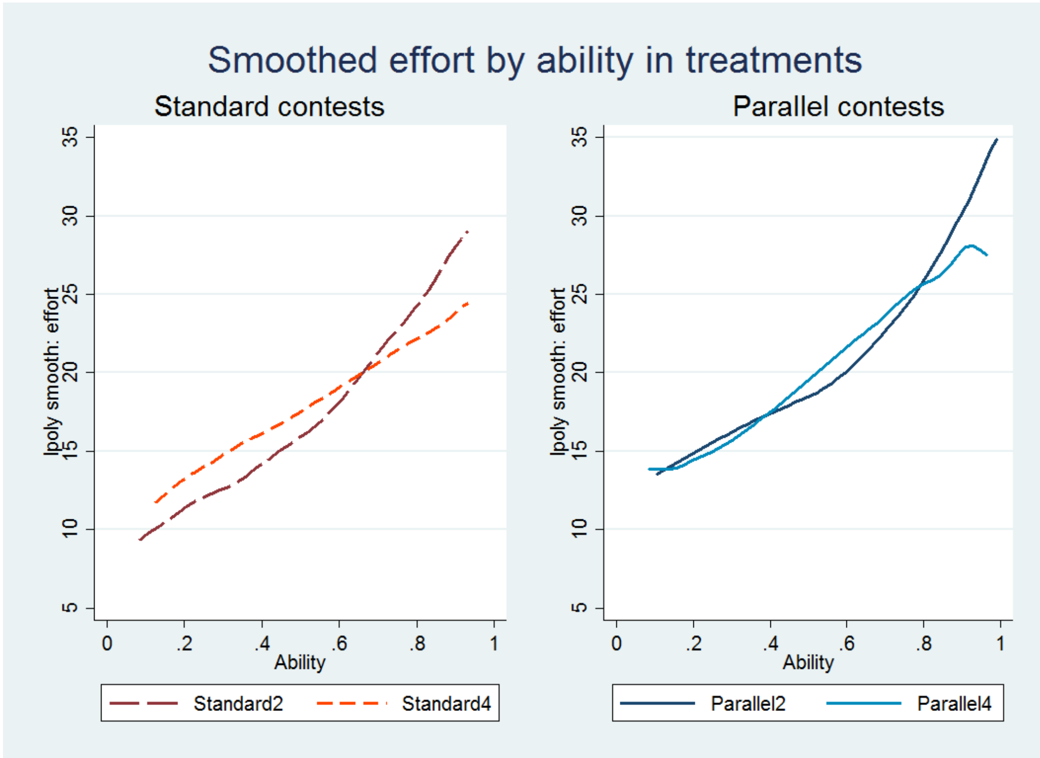


Figure 5: Smoothed effort by ability

is true for low-ability players and the difference is 10% significant. In the parallel contests, the level of effort is 10% significantly higher in the case of two prizes than in the case of four prizes for high-ability players. There is no significant difference in the efforts of the lower ability players.

Support. First, figure 5 shows the smoothed efforts by abilities grouped by treatments with the same contest design. On the left side the standard contest treatments are depicted. The smoothed lines show the relation in line with the theory: lower ability credit specialists exert, on average, higher efforts in four-prize treatment while higher ability credit specialists exert, on average, higher effort in two-prize treatment. The smoothed lines cross at ability equal 0.66, while the theoretical crossing point is 0.70 (see figure 3). In order to check the significance of the differences of efforts we regress the efforts in the standard treatments on the ability and the interaction of ability and the dummy variables for ability being below and above the crossing point of smoothed lines (0.66). Columns 1 to 3 of Table 6 presents the results of the OLS estimation. Controlling for individual characteristics, the average effort in Standard2 is significantly higher than effort in Standard4 for abilities above 0.66. The average effort in Standard4 is 10% significantly lower than in Standard2 for abilities below 0.66. Thus, we find clear support for the predictions of the effect of the splitting of the prizes in standard contests.

The right side of Figure 5 shows smoothed efforts by abilities in the parallel treatments. Unlike the theoretical predictions, the observed smoothed lines cross three times. In theory they cross at ability 0.65. In order to formally test hypothesis 3 we take the last crossing point, at ability

Table 6: Efforts in contests relative to the control group

	(1) effort Standard	(2) effort Standard	(3) effort Standard	(4) effort Parallel	(5) effort Parallel	(6) effort Parallel
Ability	31.74***	25.90***	25.70***	32.05***	27.02***	23.88***
	(2.87)	(3.28)	(3.83)	(3.06)	(3.61)	(4.78)
Dummy for 2 prizes	-.73			-.17		
	(1.09)			(1.15)		
Dummy below in 2 prizes		-2.23*	-2.04*		-1.00	-1.52
		(1.14)	(1.15)		(1.17)	(1.16)
Dummy above in 2 prizes		4.47**	3.90*		5.81**	4.95*
		(1.90)	(1.98)		(2.66)	(2.89)
Constant	1.88	4.76***	5.77*	3.88**	6.43***	8.71***
	(1.61)	(1.78)	(2.92)	(1.74)	(1.99)	(3.04)
Individual controls	no	no	yes	no	no	yes
Observations	115	115	115	113	113	113
R^2	.52	.55	.60	.50	.54	.60
F-test	61.31	22.09	11.43	55.17	20.99	11.29

Dummy below in 2 prizes is 1 if ability is below the crossing point in 2 prizes treatment
Dummy above in 2 prizes is 1 if ability is above the crossing point in 2 prizes treatment
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Individual controls include all variables from Table 2

0.72, and test the significance of the differences of efforts in treatments in the same way as in standard treatments. Columns 4 to 6 of Table 6 present the results of the OLS regression of efforts on the dummy variable for two prizes and the interaction of this dummy variable with dummy variables for being above and below 0.72 in the parallel treatments. Controlling for individual characteristics, the average effort in Parallel2 is 10% significantly higher than effort in Parallel4 for abilities above 0.72. There is no significant difference in efforts for abilities below 0.72. Note that in equilibrium we expect almost the same level of efforts in the parallel contests for lower ability players (hypothesis 3), thus we find support for the predictions of the effect of splitting the prizes in the parallel contests.

Overall, in spite of the lack of strong significance, the relation of average efforts by ability in the case of two and four prizes gives support for hypothesis 3. Thus, unlike the between-contest comparisons, the results of the experiment support the equilibrium predictions within contests.

Next, the results for parallel contests are analyzed in more detail. The equilibrium of the parallel contests model makes prediction about the choices of prizes and the effort, given the choice, which resulted in hypotheses 4 and 5.

Result 4 (Choice of prizes in parallel contests): There is no significant difference between the observed and theoretical probability of choosing the high prize for specialists with abilities above the cutoff. Specialists with abilities below the cutoff choose the high prize significantly more often than the equilibrium suggests.

Support. Figure 6 presents the average proportion of credit specialists choosing the high prize

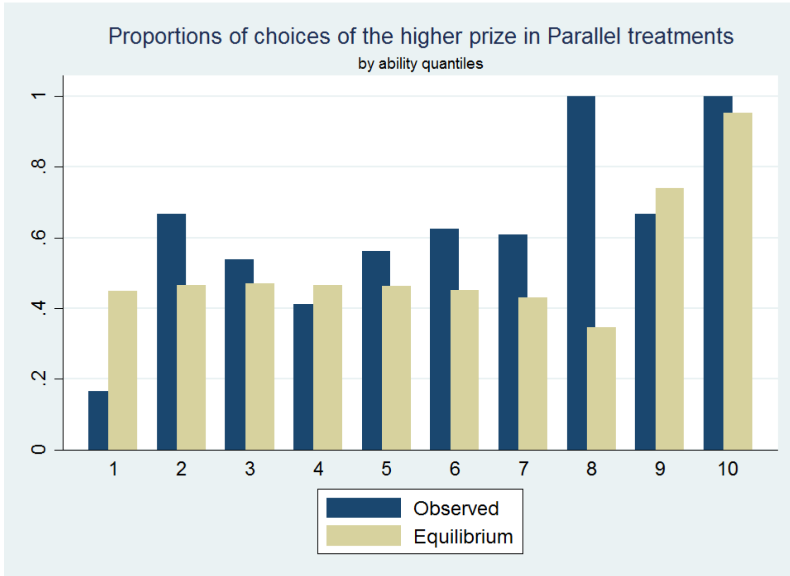


Figure 6: Choice of the higher prize, by ability quantiles.

by ability quantiles in both parallel treatments. For abilities above the theoretical cutoffs, the Wilcoxon matched-pairs signed-ranks test for equality of the observed and equilibrium probability of choosing the best colleges fails to reject the difference (two sided p-value is 0.32).

For the abilities below the cutoff, there is a significant difference between predicted probability of choice and observed average probability (Wilcoxon matched-pairs signed-ranks $p<0.01$). The main difference comes from the credit specialist just below the cutoff, thus, middle-ability players choose the high prize significantly more often than the equilibrium suggests. This is consistent with possible overconfidence in own abilities or over-optimism about the draw of abilities of the competitors. It is worth noticing that this observation is in line with the result Hafalir et al.'s (2014) lab experiment. Their subjects also choose the good college more often than suggested by equilibrium.

One important feature of the equilibrium in parallel contests is the independence of the effort from the choice of the prize. The following result tests this pattern in the data.

Result 5 (Choice of effort given prize choice in Parallel contests): Controlling for ability, there is no significant difference in effort, depending on the choice of prize in Parallel2 and Parallel4 treatments.

Support. Table 7 presents the results of the estimation of regression of effort levels in Parallel2 and Parallel4 depending on the choice of the prize. The variable choice is a dummy variable that equals one if the high prize is chosen. Row 2 of the table shows the coefficient of the choice dummy under different model specifications. The coefficients in Parallel2 treatments are negative and not significant. The coefficients in Parallel4 treatment are positive and not significant. Thus, we conclude that there is no evidence that credit specialists condition their effort on the actual choice of prize, which is in line with equilibrium prediction. Thus, we cannot reject hypothesis 5.

Table 7: Linear regressions of efforts in contests depending on the choice of the prize.

Effort	Paral2	Paral2	Paral4	Paral4
Ability	39.55***	40.23***	22.75***	16.32**
	(4.28)	(4.60)	(4.71)	(6.72)
Choice	-.51	-1.29	2.08	1.60
	(1.78)	(1.82)	(1.69)	(1.60)
Constant	.02	5.37	7.43***	12.15***
	(2.24)	(4.07)	(2.49)	(4.14)
Controls	no	yes	no	yes
Observations	55	55	58	58
R^2	.66	.72	.35	.54

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Standard errors in parentheses
Choice is a dummy equal to 1 if the high prize is chosen
Individual controls include all variables from Table 2

Finally, we test whether the theoretical predictions for the effort level have explanatory power for the observed efforts.

Result 6 (Point predictions and realized efforts): The theoretical predictions have significant predictive power for the realized efforts. Moreover, controlling for the predictions, the parallel treatments lead to significantly higher efforts than the standard treatments.

Support. Table 8 shows the results of the OLS regressions of the efforts on the predicted effort, controlling for abilities and the individual controls. Predicted effort has a significant effect on the observed efforts in all specifications. The inclusion of predicted effort explains the treatment difference of standard contests treatments relative to the control group, while dummy variables for the parallel treatments still remain significant. Thus, we can interpret this as overexertion of effort relative to the equilibrium predictions in the parallel contests. This observation supports findings of Hafalir et al. (2014) from the lab.

There are three potential candidates to explain relative overexertion of the effort in the parallel contest in comparison to the standard contests.

The first candidate is risk-aversion. Fibich et al. (2006) show that risk-averse high ability bidders would bid more than risk-neutral bidders, while low ability risk-averse bidders would bid less than risk-neutral. In the parallel contests, higher ability types have more to lose, as they do not receive the worse prize in case of losing the best prize, and thus exert even more effort than in the standard contests if risk âaverse.

The second candidate is loss-aversion, in line with the reasoning of Müller and Schotter (2010). In the parallel contests, players with abilities just below the cutoff who chose the worse prize, have in equilibrium almost certain chance of winning it (higher than in the standard contests) due to the absence of competition from higher ability players. Thus their reference point is formed around having the worse prize. This leads to the fact that they would bid more in the parallel contests to compensate for possible disutility in the case of not winning the worse prize. The disutility is explained by the loss-aversion.

The third candidate is the joy of winning Cooper and Fang (2008). If the joy of winning is pronounced only for the best prize winners in the standard contests, as receiving the worse prize also means losing to someone, it is pronounced for all winners of prizes in the parallel contests. Once the prize is chosen, winning even the worse prize constitutes being the best among competitors, and thus might lead to the joy of winning. Thus the parallel contests enlarge the number of players with the utility from the joy of winning from the number of the best prizes to the total number of prizes. Thus the parallel contests lead to higher overexertion of effort relative to standard contests.

Table 8: Linear regression of efforts of all credit specialists on the predicted effort.

	effort	effort
Ability	17.51***	17.25***
	(2.78)	(3.25)
Predicted effort	1.50***	1.16***
	(.28)	(.29)
Standard2		.72
		(1.21)
Parallel2		3.82***
		(1.24)
Standard4		1.50
		(1.20)
Parallel4		4.54***
		(1.20)
Constant	7.53***	5.55**
	(1.28)	(2.22)
Controls	no	yes
Observations	286	286
R^2	.45	.53

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Individual controls include all variables from Table 2

3.4 Profitability of the contests

In this section we evaluate the results of the introduction of the contests with regard to their profitability to the firm. One important question to clarify is the effect of the contests' incentives on the quality of issued credits. As credit specialists are the ones to make the final decision about the creditworthiness of a client, one can expect that, in a bid to win the contest, a credit specialist might be less strict in the assessment of the risk of the client. The quality for each credit specialist is determined as a coefficient of the portfolio at risk of the credits issued to the new clients in February. This consideration is an important step in evaluating the overall profitability of the contest for the firm.

To address this question, the data on the PAR7 coefficient of the new clients issued in February 2015 were collected for each credit specialist on April 1, 2016. Note that the maximum term of credits issued for new clients was 12 months. The collected data we treat as final, though there are can be more changes in PAR, as some of delayed payments are paid after the term is over, but we abstract from them.[8] Note that some credit specialists no longer work in the company but the credits are still registered to their names[9], thus we do not lose this data. Table 9 presents the marginal effects of the probit regressions of the average PAR7 coefficients of credits issued in February to new clients by each credit specialist on the effort and the treatments dummy.

Table 9: Marginal effect of probit model for PAR7 of issued credits

	(1)	(2)	(3)
	PAR7	PAR7	PAR7
Standard2 (d)	.03	.02	.03
	(.08)	(.08)	(.08)
Parallel2 (d)	.11	.10	.11
	(.07)	(.08)	(.08)
Standard4 (d)	.08	.07	.08
	(.07)	(.08)	(.08)
Parallel4 (d)	.09	.07	.08
	(.08)	(.08)	(.08)
Effort	.00	.01*	.00
	(.00)	(.00)	(.00)
Ability			.14
			(.21)
Controls	no	yes	yes
Observations	286	286	286
log(likelihood)	-166.88	-164.06	-163.83

(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Individual controls include all variables from Table 2

The effort of the credit specialists has no significant effect on the quality of the issued credit, neither have contests, on average, relative to the control group. Thus, in an estimation of the profitability of the contests we assume that additional efforts in the contest treatments have the same average quality as the credits in the control group.

Given the budget of 3,000 rubles per participant we estimate the average cost of new clients in each treatment, taking an estimation of the treatment effects from column 3 of Table 3. This leads to the following estimated costs of one new client: 1,364 rubles in Standard2, 556 rubles in Parallel2, 1,003 rubles in Standard4, and 519 rubles in Parallel4. In all treatments the cost of new credit is lower than the expected profit of an average credit.Minimum expected (given the average repayment rate) profit of a credit to new clients was 2160 rubles, without cost of capital. That was a credit for three months of 10,000 rubles. However, the company has an alternative source of attracting new clients, called "the agents' scheme", when non-employed people who attract a client receive 400 rubles for each attracted client and give a 200-rubles discount to the client. Thus,

[8] In an earlier version of the paper we reported the same data collected on December,1, 2015, when some credits still were open. The current database has on average 0,5% lower PAR7, but it did not change marginal effect estimation at all. Thus we treat it as evidence that the PAR7 coefficient is final.

[9] In our data, while in company they are assigned to one of the current employees.

the benchmark to compare the effectiveness of the contest for the company is 600 rubles (insisted by the management of the company). Both parallel contests led to lower costs. The results of the parallel treatments were accepted as successful for the company by the CEO, with a plan to repeat the the contests with parallel design. While the calculation of the benefits of the contest and its profitability is simplified, it provides first idea about the magnitude of the effect for the company.

4 Conclusions

The theoretical contest literature has developed various alternatives of contest designs, each of which offers different advantages. Motivated by Hafalir et al.'s (2014) recent model and the evidence from lab experiments that the parallel design leads to higher effort than the standard design, even when theory predicts the opposite, we conducted a field experiment to test this contest variation against the standard all-pay auction design.

Our main finding is that, as in the lab, the parallel contests lead to significantly higher efforts of participants than a standard all-pay auction design. In line with the theory, the main benefit comes from lower ability players, who exert higher efforts in parallel contests due to separating themselves from the high-ability competitors in the standard contests. In contrast to the theory, we do not observe relative under-exertion of efforts in parallel contests for the players around the cutoff-ability. The predictions of equilibrium efforts explain the treatment effect of standard contests, but in parallel contests there is an additional positive effect, which is not explained by the theory. This might be explained by risk-aversion, loss aversion or joy of winning.

As for the effect of splitting the prizes, the effect is in line with the theoretical prediction: high-ability specialists prefer a small number of high prizes in all contests, while the lower ability specialists prefer a higher number of smaller prizes in standard contests.

In the parallel contests we find evidence that credit specialists choose the higher prize too often relative to equilibrium. The biggest difference comes from the credit specialists just below the ability cutoff, which might be partially explained by the overestimation of one's own relative ability. This finding is also in line with the lab findings of Hafalir et al. (2014). We find no support for specialists conditioning their effort on the choice of the prize, which is in line with the equilibrium prediction.

Finally, we check the effects of the short-term contest incentives on the quality of the issued credits, and find no significant effect. Altogether, this leads to estimated costs of new clients for the company that are lower than accepted by the management in parallel contests but not in standard contests. The experiment shows that parallel contests might be a good and easy change from standard contests for a designer who aims to maximize the effort. However, long-term effects of the parallel design might differ and are to be studied.

References

Buchanan, J. M., R. D. Tollison, and G. Tullock (1980): *Toward a theory of the rent-seeking society*, 4, Texas A & M Univ Pr.

Buyukboyaci, M. (2012): "Parallel Tournaments," Working paper.

Cason, T. N., W. A. Masters, and R. M. Sheremeta (2010): "Entry into winner-take-all and proportional-prize contests: An experimental study," *Journal of Public Economics*, 94, 604–611.

Cooper, D. J. and H. Fang (2008): "Understanding overbidding in second price auctions: An experimental study," *The Economic Journal*, 118, 1572–1595.

De Paola, M., V. Scoppa, and R. Nisticò (2012): "Monetary incentives and student achievement in a depressed labor market: Results from a randomized experiment," *Journal of Human Capital*, 6, 56–85.

Dechenaux, E., D. Kovenock, and R. M. Sheremeta (2015): "A survey of experimental research on contests, all-pay auctions and tournaments," *Experimental Economics*, 18, 609–669.

Eriksson, T., S. Teyssier, and M.-C. VILLEVAL (2009): "Self-selection and the efficiency of tournaments," *Economic Inquiry*, 47, 530–548.

Fibich, G., A. Gavious, and A. Sela (2006): "All-Pay Auction with Risk-Averse Bidders," *International Journal of Game Theory*, 34, 583–599.

Forbes, C., M. Evans, N. Hastings, and B. Peacock (2011): *Statistical distributions*, John Wiley & Sons.

Hafalir, I. E., R. Hakimov, D. Kübler, and M. Kurino (2014): "College admissions with entrance exams: Centralized versus decentralized," Tech. rep., WZB Discussion Paper.

Harbring, C. and B. Irlenbusch (2011): "Sabotage in tournaments: Evidence from a laboratory experiment," *Management Science*, 57, 611–627.

Moldovanu, B. and A. Sela (2001): "The Optimal Allocation of Prizes in Contests," *American Economic Review*, 91, 542–558.

Müller, W. and A. Schotter (2010): "Workaholics and Dropouts in Organizations," *Journal of the European Economic Association*, 8, 717–743.

Nalbantian, H. R. and A. Schotter (1997): "Productivity under group incentives: An experimental study," *The American Economic Review*, 314–341.

A Appendix

A.1 Theoretical predictions

Proposition 1 *In the standard contest, there is a unique symmetric equilibrium such that for each $a \in [0,1]$, each student with ability a chooses an effort e(a) according to*

$$e(a) = \left[\int_0^a x \left\{ f_{10-q_2,9}(x)\, m_2 + \left(f_{10-q_1-q_2,9}(x) - f_{10-q_2,9}(x) \right) m_1 \right\} dx. \right]^{\frac{1}{\alpha}} \tag{1}$$

where $f_{k,m}(\cdot)$ for $k \geq 1$ is a density of the k^{th}- (lowest) order statistic out of m independent random variables that are identically distributed according to F.

This is a special case of the all-pay auction studied by Moldovanu and Sela (2001). We use Hafalir et al.'s (2014) formulation. One modification from Proposition 1 of Hafalir et al. (2014) is to allow for the cost function to be convex. We used their proof with a modified function for the costs of effort to derive the equilibrium effort formula (1).

Proof. Suppose that $e(a)$ is a symmetric equilibrium effort function that is strictly increasing. Consider a student with ability a who chooses an effort as if her ability is a'. Her expected utility is

$$m_2\, F_{10-q_2,9}(a') + m_1 \, \left(F_{10-q_2-q_1,11}(a') - F_{10-q_2,9}(a') \right) - \frac{1}{a} \cdot e(a')^{\alpha}.$$

The first-order condition at $a' = a$ is

$$m_2\, f_{10-q_2,9}(a) + m_1 \, \left(f_{10-q_2-q_1,9}(a) - f_{10-q_2,9}(a) \right) - \frac{1}{a} \cdot \alpha \cdot e(a)^{\alpha-1} \cdot e'(a) = 0.$$

$$\Rightarrow \alpha \cdot e(a)^{\alpha-1} \cdot e'(a) = a \cdot m_2\, f_{10-q_2,9}(a) + a \cdot m_1 \, \left(f_{10-q_2-q_1,9}(a) - f_{10-q_2,9}(a) \right).$$

Thus, by integration and as the boundary condition is $e(0) = 0$, we have

$$[e(a)]^{\alpha} = \left[\int_0^a x \left\{ f_{10-q_2,9}(x)\, m_2 + \left(f_{10-q_1-q_2,9}(x) - f_{10-q_2,9}(x) \right) m_1 \right\} dx. \right].$$

□

In the parallel contests, each player $i \in I$ simultaneously chooses one of the prizes, M_i and an effort e_i. Given the prize choices of students $(M_i)_{i \in I}$ and efforts $(e_i)_{i \in I}$, each Prize M is awarded to players with the top q_M effort levels among the set of players who chose the prize $(\{i \in I \,|\, M_i = M\})$. The unique symmetric Bayesian equilibrium of this game is characterized in Hafalir et al. (2014), and the following Proposition is a special case of it, with a modification allowing for convexity of the cost function.

Proposition 2 *In a parallel contest, there is a* unique *symmetric equilibrium* $(\gamma, e; c)$ *where a player with type* $a \in (0, c]$ *chooses the monetary prize 1 (smaller prize) with probability* $\gamma(a)$ *and makes effort* $e(a)$*; and a player with type* $a \in [c, 1)$ *chooses prize 2 (higher prize) for sure and makes effort* $e(a)$*. Specifically,*

$$e(a) = \left[m_2 \int_0^a x \sum_{j=q_2}^{9} p_{9-j,j}(\pi(c)) h_{j-q_2+1,j}(x) dx \right]^{\frac{1}{\alpha}}.$$

where $\pi(a)$ *is the ex-ante probability that a player has a type less than* a*, and is given by:*

$$\pi(a) := \int_0^a \gamma(x) f(x) dx.$$

where $p_{j,k}(\pi(c))$*is the probability that out of* $j + k$ *students,* j *players choose Monetary Prize 1 and* k *players choose Monetary Prize 2, and is given by:*

$$p_{j,k}(x) := \binom{j+k}{j} x^j (1-x)^k.$$

where $h_{j,k}$ *is density of* $H(a)$ *– the probability that a type is less or equal to* a*, conditional on the event that she chooses Monetary Prize 2, and it is given by:*

$$H(a) = \begin{cases} \frac{F(a)-\pi(a)}{1-\pi(c)} & \text{if } a \in (0, c], \\ \frac{F(a)-\pi(c)}{1-\pi(c)} & \text{if } a \in [c, 1]. \end{cases}$$

The equilibrium cutoff c *and the mixed strategies* $\gamma(\cdot)$ *are determined by the following four requirements:*

(i) $\pi(c)$ *uniquely solves the following equation for* x

$$m_1 \sum_{j=0}^{q_1-1} p_{j,9-j}(x) = m_2 \sum_{m=0}^{q_2-1} p_{9-j,j}(x).$$

(ii) *Given* $\pi(c)$*,* c *uniquely solves the following equation for* x

$$m_1 = m_2 \sum_{j=0}^{q_2-1} p_{9-j,j}(\pi(c)) + m_2 \sum_{j=q_2}^{9} p_{9-j,j}(\pi(c)) \sum_{l=j-q_2+1}^{j} p_{l,j-l} \left(\frac{F(x)-\pi(c)}{1-\pi(c)} \right).$$

(iii) *Given $\pi(c)$ and c, for each $a \in [0, c)$, $\pi(a)$ uniquely solves the following equation for $x(a)$*

$$m_2 \sum_{j=q_2}^{9} p_{9-j,j}(\pi(c)) \sum_{l=j-q_2+1}^{j} p_{l,j-l}\Big(\frac{F(a)-x(a)}{1-\pi(c)}\Big) = m_1 \sum_{j=q_1}^{9} p_{j,9-j}(\pi(c)) \sum_{l=j-q_1+1}^{j} p_{l,m-l}\Big(\frac{x(a)}{\pi(c)}\Big).$$

(iv) *Finally, for each $a \in [0, c]$, $\gamma(a)$ is given by*

$$\gamma(a) = \frac{\pi(c)B(a)}{(1-\pi(c))A(a) + \pi(c)B(a)} \in (0, 1),$$

where

$$\begin{aligned} A(a) &:= m_1 \sum_{j=q_1}^{9} p_{j,9-j}(\pi(c))\, j\, p_{j-q_1,q_1-1}\Big(\frac{\pi(a)}{\pi(c)}\Big), \\ B(a) &:= m_2 \sum_{m=q_2}^{9} p_{9-j,j}(\pi(c))\, j\, p_{j-q_2,q_2-1}\Big(\frac{F(a)-\pi(a)}{1-\pi(c)}\Big). \end{aligned}$$

Proof. The proof of Proposition 2 is given in Hafalir et al. (2014). The only modification is made in the step of derivation of the symmetric effort function, where the linear cost function is substituted with $\frac{1}{a_i} \cdot e_i^{\alpha}$. Thus, similar mechanics are performed as in the case of the standard contest. □

A.2 Letters to credit specialists in each of the treatments

Standard2

In order to increase productivity we are introducing a competition for monetary prizes. You will compete in attracting NEW clients. Every one of you is competing with nine other credit specialists who were randomly selected from all our branches in Russia. There is only a small probability that you will be competing against someone from your own office. Your task is to attract the maximum number of new clients in February.

In every group of 10, the winner (the credit specialist who attracts the highest number of new clients) will receive the prize of 20,000 RUB. The second place will receive a prize of 10,000 RUB. After the competition is over, you will receive the names of your direct competitors and the number of clients they attracted.We have done this to guarantee the transparency of results In case of attracting the same number of clients, the credit specialist who attracted the last client earlier has priority.

For instance, a computer randomly determines the following credit specialists to be in one competing group: Asel from Vladivostok, Bahodyr from Moscow, Djazgul from Novokuznetsk, Mirbek from Kaliningrad, Tahmina from Saint-Petersburg, Nasiba from Tver, Sergei from Ufa, Kunduz from Murmansk, Elena from Irkutsk and Jyldyz from Kazan. None of these credit specialists knows who was picked to be in the same group with him or her. Imagine they attract the following number of NEW clients in February:

Credit specialist	Number of new clients in February
Tahmina from Saint-Petersburg	41
Asel from Vladivostok	35
Sergei from Ufa	35
Jyldyz from Kazan	29
Nasiba from Tver	24
Bahodyr from Moscow	21
Djazgul from Novokuznetsk	12
Kunduz from Murmansk	12
Mirbek from Kaliningrad	9
Elena from Irkutsk	8

Tahmina attracted the highest number of new clients and won 20,000 RUB. Asel and Ulan attracted the same number of new clients, but the last client of Asel took a credit on February 27, while the last client of Sergei took a credit on February 28. That is why Asel won 10,000 RUB.

Each one of you has a big chance to win a prize! Everything is in your hands! Good luck!

Parallel2:

In order to increase productivity we are introducing a competition for monetary prizes. You will compete in attracting NEW clients. Every one of you is competing with nine other credit specialists who were randomly selected from all our branches in Russia. There is only a small probability that you will be competing against someone from your own office. Your task is to attract the maximum number of new clients in February.

In every group of 10 credit specialists, there are two prizes to compete for 20,000 RUB and 10,000 RUB. Each one of you has to choose the prize for which you want to compete before February 1. Send an sms with your name and surname, and the prize you choose (10 or 20) to the number +79267608072. You will only be competing with those credit specialists from your group of 10 who choose the same prize. The credit specialist with the highest number of new clients among those who chose 20,000 RUB will receive 20,000 RUB. The credit specialist with the highest number of new clients who chose 10,000 RUB will receive 10,000 RUB. It may be that everyone in the group of credit specialists will choose the same prize, then the second prize will not be awarded to anyone. If one of the prizes is chosen just by one credit specialist out of 10, then he or she will receive it in any case. However, you will not know how many credit specialists of your group have chosen the same prize until the end of the competition. After the competition is over, you will receive the names of your direct competitors, their choice of prizes, and the number of clients they attracted. In case of attracting the same number of clients, the credit specialist who attracted the last client earlier has priority.

For instance, a computer randomly determines the following credit specialists to be in one competing group: Asel from Vladivostok, Bahodyr from Moscow, Djazgul from Novokuznetsk, Mirbek from Kaliningrad, Tahmina from Saint-Petersburg, Nasiba from Tver, Sergei from Ufa, Kunduz from Murmansk, Elena from Irkutsk and Jyldyz from Kazan. None of these picked credit specialists knows who was picked to be in the same group with him or her. Asel, Tahmina, Bahodyr, Sergei, Djazgul, and Mirbek chose 20,000 RUB before the start of the competition. Jyldyz, Nasiba, Kunduz, and Elena chose 10,000 RUB. Imagine they attract the following number of NEW clients in February:

Credit specialists who chose 20,000 RUB	
Credit specialist	Number of new clients in February
Tahmina from Saint-Petersburg	41
Asel from Vladivostok	35
Sergei from Ufa	35
Bahodyr from Moscow	21
Djazgul from Novokuznetsk	12
Mirbek from Kaliningrad	9

Credit specialists who chose 10,000 RUB	
Credit specialist	Number of new clients in February
Jyldyz from Kazan	29
Nasiba from Tver	24
Kunduz from Murmansk	12
Elena from Irkutsk	8

Tahmina attracted the highest number of new clients among those who chose 20,000 RUB, thus she won 20,000 RUB. Jyldyz attracted the highest number of new clients among those who chose 10,000 RUB, thus she won 10,000 RUB.

Each one of you has a big chance to win a prize! Everything is in your hands! Good luck!

Standard4:

In order to increase productivity we are introducing a competition for monetary prizes. You will compete in attracting NEW clients. Every one of you is competing with nine other credit specialists who were randomly selected from all our branches in Russia. There is only a small probability that you will be competing against someone from your own office. Your task is to attract the maximum number of new clients in February.

In every group of 10, the credit specialist who attract the first highest and the second highest number of new clients will receive the prize of 10,000 RUB. The third and the fourth places will receive a prize of 5,000 RUB. After the competition is over, you will receive the names of your direct competitors and the number of clients they attracted. In case of attracting the same number of clients, the credit specialist who attracted the last client earlier has priority.

For instance, a computer randomly determines the following credit specialists to be in one competing group: Asel from Vladivostok, Bahodyr from Moscow, Djazgul from Novokuznetsk, Mirbek from Kaliningrad, Tahmina from Saint-Petersburg, Nasiba from Tver, Sergei from Ufa, Kunduz from Murmansk, Elena from Irkutsk and Jyldyz from Kazan. None of these picked credit specialists knows who was picked to be in the same group with him or her. Imagine they attract the following number of NEW clients in February:

Credit specialist	Number of new clients in February
Tahmina from Saint-Petersburg	41
Asel from Vladivostok	35
Sergei from Ufa	35
Jyldyz from Kazan	29
Nasiba from Tver	24
Bahodyr from Moscow	21
Djazgul from Novokuznetsk	12
Kunduz from Murmansk	12
Mirbek from Kaliningrad	9
Elena from Irkutsk	8

Tahmina attracted the highest number of new clients and won 10,000 RUB. Asel and Ulan attracted the same number of new clients, but Asel's last client took a credit on February 27, while Sergei's last client a took credit on February 28. That is why Asel won 10,000 RUB, while Sergei won 5,000 RUB. Jyldyz took fourth place and won 5,000 RUB too.

Each one of you has a big chance to win a prize! Everything is in your hands! Good luck!

Parallel4:

In order to increase productivity we are introducing a competition for monetary prizes. You will compete in attracting NEW clients. Every one of you is competing with nine other credit specialists who were randomly selected from all our branches in Russia. There is only a small probability that you will be competing against someone from your own office. Your task is to attract the maximum number of new clients in February.

In every group of 10 credit specialists, there are two prizes to compete for 10,000 RUB and 5,000 RUB. Every one of you has to choose the prize for which you want to compete before February 1. Send an sms with your name and surname, and the prize you choose (10 or 5) to the number +79267608072. You will compete only with those credit specialists from your group of 10 who chose the same prize. Two credit specialists with the two highest numbers of new clients among those who chose 10,000 RUB will receive 10,000 RUB. Two credit specialists with two highest number of new clients who chose 5,000 RUB will receive 5,000 RUB. It may be that everyone in the group of credit specialists chooses the same prize, then the second prize will not be awarded to anyone. If one of the prizes is chosen just by one or two credit specialists out of 10, then they will receive it in any case. However, you will not know how many credit specialists of your group have chosen the same prize until the end of the competition. After the competition is over, you will receive the names of your direct competitors, their choice of prizes, and the number of clients they attracted. In case of attracting the same number of clients, the credit specialist who attracted the last client earlier has priority.

For instance, a computer randomly determines the following credit specialists to be in one competing group: Asel from Vladivostok, Bahodyr from Moscow, Djazgul from Novokuznetsk, Mirbek from Kaliningrad, Tahmina from Saint-Petersburg, Nasiba from Tver, Sergei from Ufa, Kunduz from Murmansk, Elena from Irkutsk and Jyldyz from Kazan. None of these picked credit specialists knows who was picked to be in the same group with him or her. Asel, Tahmina, Bahodyr, Sergei, Djazgul, and Mirbek chose 10,000 RUB before the start of the competition. Jyldyz, Nasiba, Kunduz, and Elena chose 5,000 RUB. Imagine they attract the following number of NEW clients in February:

Credit specialists who chose 10,000 RUB	
Credit specialist	Number of new clients in February
Tahmina from Saint-Petersburg	41
Asel from Vladivostok	35
Sergei from Ufa	35
Bahodyr from Moscow	21
Djazgul from Novokuznetsk	12
Mirbek from Kaliningrad	9

Credit specialists who chose 5,000 RUB	
Credit specialist	Number of new clients in February
Jyldyz from Kazan	29
Nasiba from Tver	24
Kunduz from Murmansk	12
Elena from Irkutsk	8

Tahmina attracted the highest number of new clients among those who chose 10,000 RUB, thus she won 10,000 RUB. Asel and Ulan attracted the same number of new clients and both chose 10,000 RUB, but Asel's last client took credit on February 27, while Sergei's last client took credit on February 28, that is why Asel won 10,000 RUB. Jyldyz attracted the highest number of new clients among those who chose 5,000 RUB, thus she won 5,000 RUB, as well as Nasiba who took the second place among those who chose the 5,000 RUB.

Each one of you has a big chance to win a prize! Everything is in your hands! Good luck!

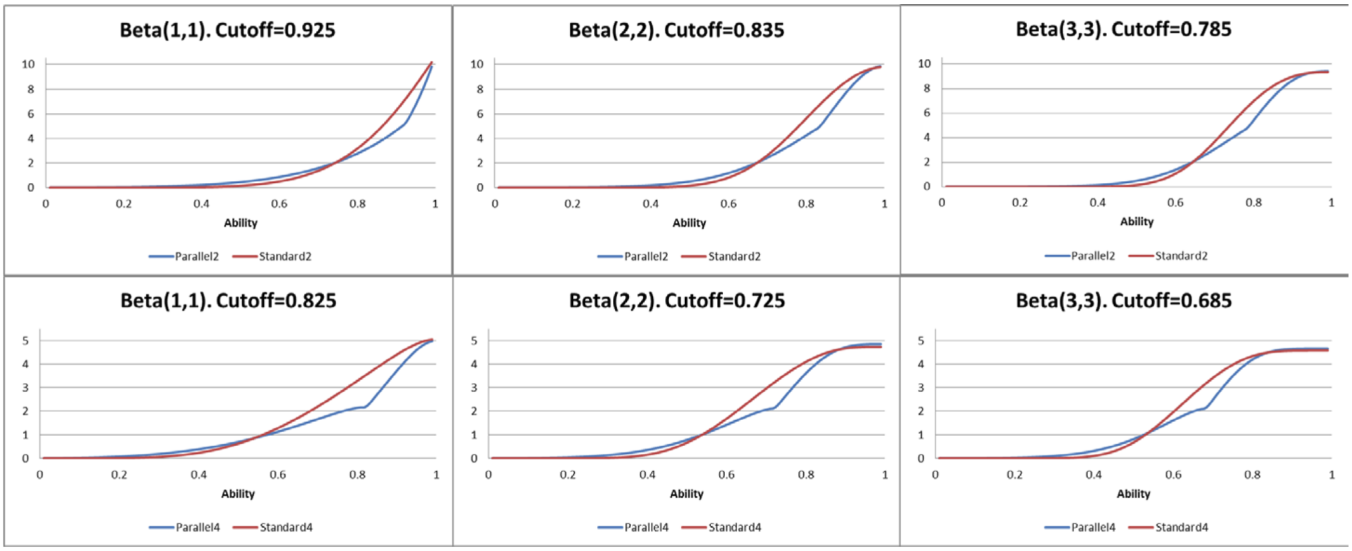


Figure 7: Comparison of predicted efforts between models depending on distribution of abilities

A.3 Simulations of effort functions by treatments given different cost functions and ability distributions

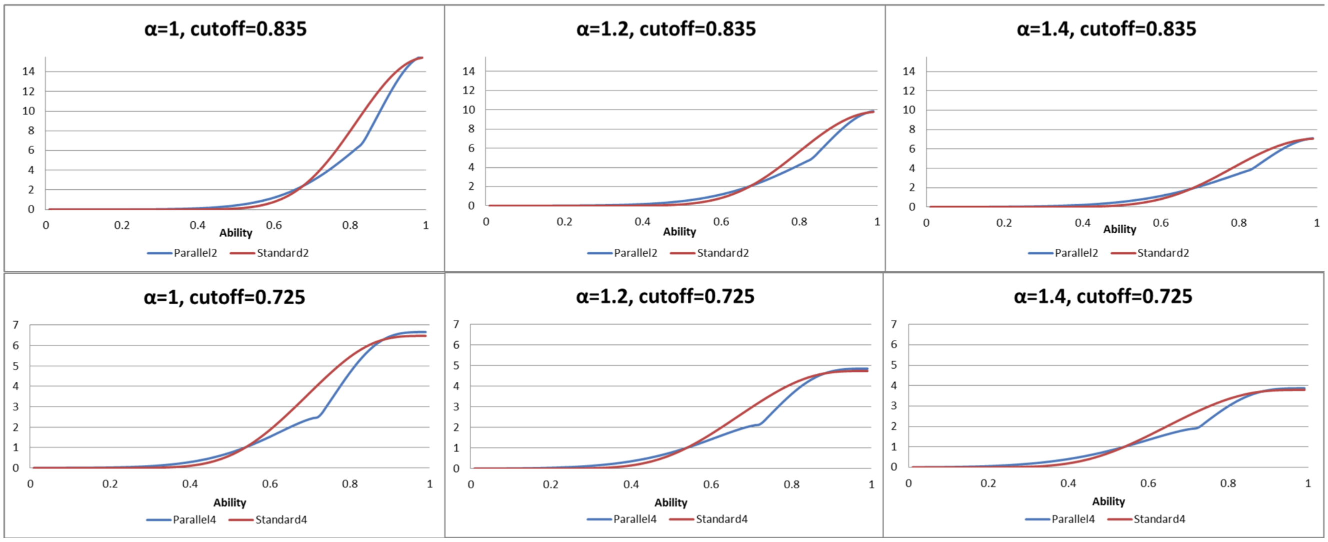


Figure 8: Comparison of predicted efforts between models depending on parameter α of the cost function

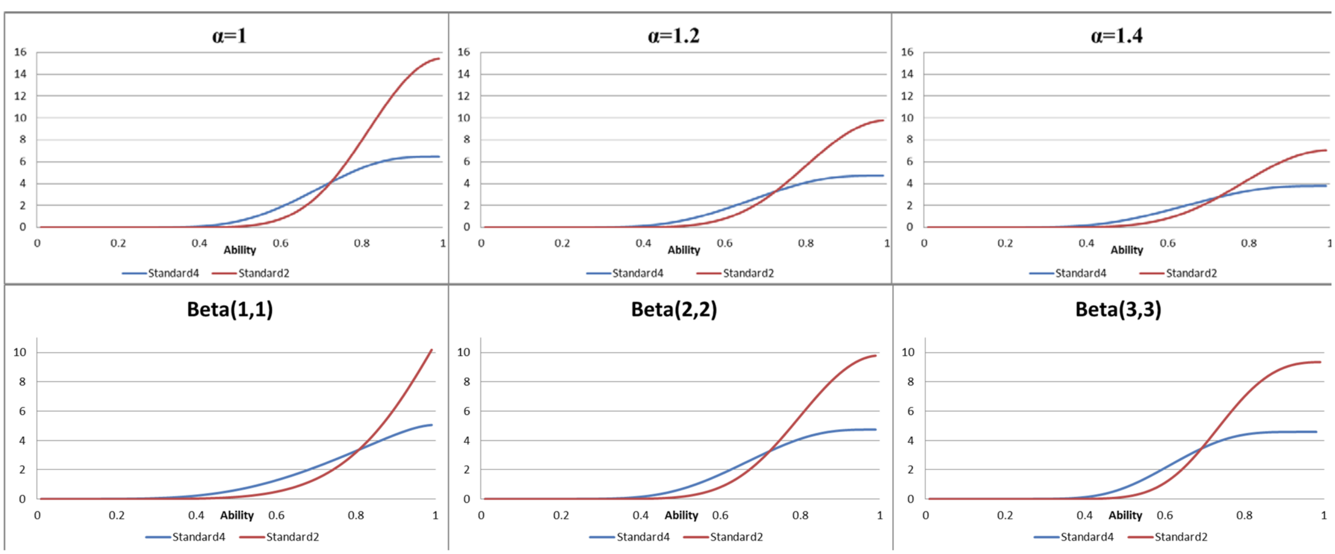


Figure 9: Comparison of predicted efforts of standard contests depending on parameter α of the cost function and distribution of abilities

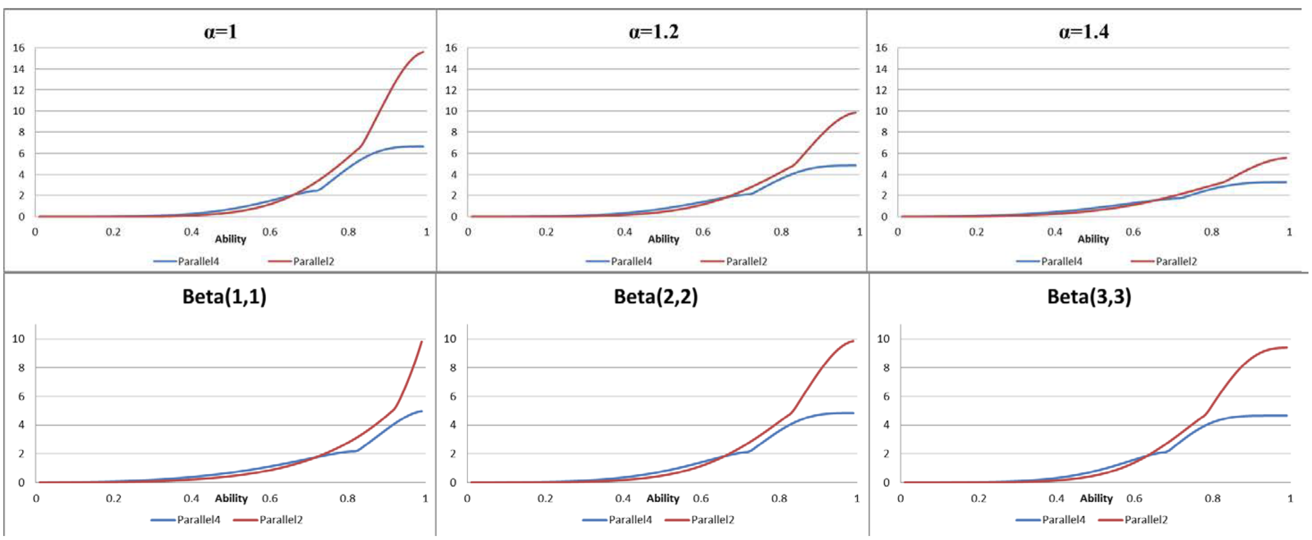


Figure 10: Comparison of predicted efforts of parallel contests depending on parameter α of the cost function and distribution of abilities

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